FRESNO SURFACE WATER TREATMENT FACILITY

OPERATION PLAN

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It is our goal to *deliver safe, quality water – to our community – affordably and reliably.*

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SECTION 1: OPERATION STAFF AND RESPONSIBILITIES

TITLE:	NAME:	GRADE:	OPER #	PHONE (Cell)
Chief Operator	(b) (6) [redacted]	5	(b) (6) [redacted]	[redacted]
Chief of Operations	[redacted]	4	[redacted]	[redacted]
Senior Operator	[redacted]	4	[redacted]	[redacted]
Operator	[redacted]	4	[redacted]	[redacted]
Operator	[redacted]	4	[redacted]	[redacted]
Operator	[redacted]	4	[redacted]	[redacted]
Operator	[redacted]	3	[redacted]	[redacted]
Operator	[redacted]	3	[redacted]	[redacted]
Operator	[redacted]	3	[redacted]	[redacted]

Operator	[redacted]	3	[redacted]	

1.1 ~~1.1~~ Plant Administration

Chief Operator
Responsible for oversight of day to day operations of the treatment plant.

Chief of Operations
Directs and oversees: plant administration (budget, goals & procedures, staff development, recordkeeping, etc), laboratory activities, maintenance and preventive maintenance projects. ~~Implements~~ Stays abreast of developing Federal and State ~~Water~~ water regulations and maintains contact with government agencies.

Senior Operator
Prepares shift schedules for operators. Selects and orders chemical supplies. Responds to water quality complaints. Oversees day-to-day operation of the facility and assists with the preparation of ~~-~~reports to State and local officials.

1.2 Operators:
Conduct water treatment plant operation: Flow rates adjustments, estimate water demand and place raw water orders. Conduct mineral, physical and coliform analyses for control and monitoring of treatment process. Determine treatment mode, select chemical applications and calculate chemical doses. Prepare chemical stock solutions for water treatment. Backwash filters. Calibrate turbidimeters and pH meters. Maintain meticulous plant operation logs. Evaluate condition of mechanical equipment and perform repairs as needed.

1.3 Weekday, Weekend and Holiday Coverage:

The Fresno City Water Treatment Facility is staffed 24 hours a day, 7 days a week. During non-business hours a **~~Stand~~stand-by operator** is designated to be in telephone or pager range to assist the ~~On~~on-~~Duty~~ duty ~~Operator~~ operator if needed.

SECTION 2: MONITORING PLAN

2.1 Constituents Monitored:

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pH - Manually measured in the Laboratory every four (4) hour(s): influent, settled, filtered, and treated water. In addition, continuous in-line monitoring is performed on the influent, pre-filter, post-filter, and treated water sample locations.

Turbidity - Manually measured in the laboratory every four (4) hour(s); influent, settled, filtered and treated water with a Hach 2100N turbidimeter. Continuous in-line monitoring is also performed; influent water with a Hach Surface Scatter Turbidimeter, settled water with a Hach ~~1720C~~1720E, Treated water, Combined Filter Effluent (CFE), and all 6 individual filters with Hach 1720E turbidimeter. In addition, there are in-line particle counters on both the raw water and combined filter water effluent.

Chlorine - In-line free chlorine analyzers (Hach ~~1720D~~CL17) measure residuals at both the inlet to the treated water reservoir and just prior to entry into the distribution system.

Ozone – Ozone in the Ozone Contact Basins is monitored at three locations along each of two contact basins using Orbisphere (Model #26506) in-line instrumentation. Each ozone monitor is strategically located in the ozone contact chamber and able to sample dissolved ozone from several depths within the contact cell: the first and second monitors are able to sample at different locations within cell 1, 2 and 3 (for CT compliance). The last monitors, located near the effluent of the contact basins (cells 7 & 8), are primarily for monitoring any dissolved residual ozone needed to be neutralized prior to filtration.

Other monitoring – Additional water quality monitoring is performed in the plant laboratory:

Coliform Analysis - Raw (density counts) and combined filter effluent and treated (P/A) water by MMO-MUG analyses are performed twice daily -- every 12 hours.
Alkalinity - Raw, combined filter effluent, and treated water every 12 hours.
Hardness - Raw, combined filter effluent, and treated water every 12 hours.
Chlorides - ~~-~~Raw, combined filter effluent, and treated water every 12 hours.

Temperature - Raw, combined filter effluent, and treated water every 12 hours.
Conductivity — Raw, combined filter effluent, and treated water every 12 hours.

2.2 Calibration:
pH meters, chlorine analyzers, ozone probes, turbidimeters, and particle counters are calibrated per manufacturer's and/or regulatory requirements by operation personnel using appropriate standards.

Calibration of all in-line analyzers is performed at least quarterly and verified against laboratory instruments. When verified, if any inline analyzer deviates more than ± 10% for two consecutive 4 hour laboratory reading (must be within the range of the inline instrument to detect), the inline monitor will be recalibrated within 48 hrs or less.

<u>EXCEPT FOR:</u>

1. All turbidimeters will be verified weekly against a known standard of less than 0.5 NTU and recalibrated if the deviation is greater than ± 10 NTU. At the same time, sample flow and verification of SCADA will be documented (signal recalibration will be done if there is a ± 10% deviation or if reading less than 0.3 NTU – recalibration of recording device will be done if the deviation is greater than ± 0.03 NTU).
2. For all other inline analyzers, should 2 consecutive 4 hr laboratory readings show a deviation of more than ± 10% , that unit will be cleaned and, if necessary, recalibrated per manufactures instructions.

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SECTION 3: WATER TREATMENT PROCESS

3.1 Description of water treatment operation~~:~~
The Fresno City Water Treatment Facility utilizes conventional treatment. Primary plant process includes coagulation, clarification, ozonation, and filtration. Coagulation, flocculation, and sedimentation is achieved using proprietary treatment commonly known as Actiflo ballasted flocculation. Very fine sand is added in conjunction with cationic polymer after initial coagulation to achieve rapid flocculation and settling. This process is followed by two ozone contact

basins (to meet CT), and deep bed dual media filtration (6 foot GAC/ 9 inches sand). The design flow rate range is 10 to 30 MGD and the permitted flow is 30 MGD (with all six filters in service). Post-filtration disinfection takes place prior to the Treated Water Reservoir (TWR) with sodium hypochlorite to provide a disinfection residual for water entering the distribution system. Sodium hydroxide, carbon dioxide, and polyphosphate are also added at this point for corrosion control of the distribution network.

3.2 Raw Water Source~~:~~

Raw water is diverted from the Enterprise Canal. The Enterprise Canal is owned and operated by the Fresno Irrigation District (FID). This canal can deliver water from both the San Joaquin and Kings Rivers as well as the Friant Kern Canal. A 42-inch diameter raw water pipeline delivers water to the Raw Water Pump Station

3.3 Raw Water Pump Station~~:~~

The station consists of four 10 mgd capacity pumps, two of which are equipped with variable frequency drives (VFDs) to allow for flow rate adjustment. Normally only three of the four pumps will be in operation at one time. The fourth pump is intended as a standby pump.

An ultrasonic flow meter is located downstream of the Raw Water Pump Station to measure the flow ~~into the plant~~entering the treatment process. The signal from the flow meter is fed into the plant ~~control and instrumentation system~~SCADA system and is used to control the rate of chemical feed.

3.4 Initial Flash Mixer~~:~~

Coagulants and other treatment chemicals are fed downstream of the Raw Water Meter at the Initial Flash Mix. A stainless steel orifice plate is used to provide mixing of the treatment chemicals with the raw water. The return water from the solids drying beds is introduced just downstream of the orifice plate so that the coagulants mix with this water also.

Treatment chemicals that may be fed at the Initial Flash Mix are:

1. Alum (or ferric chloride) as the primary coagulant
2. Cationic p~~P~~olymer as a coagulant aide
3. Caustic s~~S~~oda (Sodium Hydroxide), if necessary, to raise the water pH prior to clarification.
4. Sodium hypochlorite for shock disinfection of the clarification basins, if necessary

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~~3. cation and~~

~~3.5 Sodium Hypochlorite for shock disinfection of the clarification basins, if necessary~~

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~~3.6~~3.5 Clarification

The coagulated water is distributed to two clarification basins via 30 inch inlet isolation valves. Orifice plates located at the inlets assists in providing balanced flow between the two basins.

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Each Actiflo basin consists of four separate chambers: c~~C~~oagulation , i~~I~~njection, m~~M~~aturation, and s~~S~~ettling. The first three chambers each contain vertical shaft mechanical mixers. The c~~C~~oagulation c~~C~~hamber provides intense mixing. The i~~I~~njection i~~C~~hamber also provides intense mixing and is the point at which~~for addition of coagulant polymer and~~ recycled microsand is reintroduced into the Actiflo process. Cationic polymer can also be added at this chamber or in the next.~~separated in the hydrocyclones.~~ The ~~Maturation~~ maturation ~~Chamber~~ chamber provides slower mixing of the coagulated water to allow floc formation and attachment of the microsand to the floc. ~~–~~Enmeshment of the sand in the floc in conjunction with the cationic polymer creates a high density material that is referred to as ballasted floc. The weighted floc is then settled out in the ~~Settling~~ settling ~~Chamber~~chamber, which contains lamella tube settlers to enhance the clarification process and a rotating scraper arm to collect settled sludge.~~ and lamella tube settlers to enhanced the clarification process~~. The sludge/~~micro~~ microsand mixture collected in the ~~microsand~~ settling chamber is pumped to ~~separated in the~~ hydrocyclones ~~and released back into the Injection Chamber.~~which separate the sand from the sludge and then return the recovered sand back to the injection chambers.

Settled water from the Actiflo process is collected in rectangular weir troughs and flows into an effluent channel. The effluent channel contains a slide gate to isolate the effluent of each of the Actiflo basins. Flow from the effluent channel is diverted to the o~~O~~zone c~~C~~ontact b~~B~~asins via two 30" pipeline connections, each with an isolation butterfly valve.

The slide gate and isolation valves allow flexibility to move the settled water from both Actiflo units to either ozone contactor should one be out of service or from one Actiflo unit to both ozone contactors should an Actiflo unit be out of service. ~~The slide gate also allows the operator to bring one basin on-line and to overflow while the other is in operation.~~

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The Actiflo process also contains an overflow weir and channel which can be used to divert flow back to the Raw Water Pump Station ~~intake~~ during initial start-up of the Actiflo process. To dewater the basins, mud valves are located in each coagulation and maturation chamber to drain the basins while the ~~recirculation~~

sand pumps ~~pump flow back to the Injection Chamber.~~can evacuate the settling chamber back to the injection chambers.

3.6 ~~-~~Ozonation~~:~~

Ozone serves as the primary disinfectant for inactivation of microorganisms. In addition, ozonation will oxidize the taste and odor compounds in the water and trace organic compounds that are occasionally detected.

Multiple sample ports connected to in-line ozone residual monitors will be used to monitor the concentration of ozone throughout the contactor. There are three residual ozone monitors per train and each monitor is connected to two to four sample locations. Additionally, the ozone gallery contains ambient air oxygen and ozone monitors to detect any release of gas into the gallery area. Each of the units have local displays and are~~is~~ ~~alarmed~~ tied to the plant ~~and instrumentation~~SCADA system for operator notification ~~and to local visual and audio~~with audio and visual alarms. Ozone off-gas in the contactor headspace is conveyed to one of two ozone destruct units located in the Ozone Contactor Gallery.

Calcium thiosulfate can be added at the ozone effluent channel to reduce ~~any~~ residual ~~dissolved~~ ozone in the water prior to entering the filters. This will prevent off-gassing of ozone at the filters. Sodium hydroxide (caustic soda) ~~is~~ can be fed at the last cell of each ozone contact basin to raise the pH of the water to around neutral prior to filtration. Non-ionic filter aid polymer can also be added to the ozone effluent for use as a filtration aide.

Two ozone generators housed in the ozone Generation Room located in the lower level of the Operations Building are used to supply ozone gas to the Contact Basins.

See Appendix for both SCADA and manual operation of Ozone System – including an expanded list of alarms and "failsafe" features.

3.7 ~~-~~Filtration-Adsorption~~:~~

After ozonation, the ~~partially treated~~settled and disinfected water passes to the filters. The filter~~-design at the SWTF includes~~ s are six deep-bed, dual-media filters with effluent flow control. ~~-~~The filter media ~~design~~ includes six feet of granular activated carbon (GAC) over 9 inches of silica sand. Additional filters will be added when the plant is expanded in capacity.

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The GAC provides both a filtration~~ media~~ and ~~an ~~adsorption media. The filters remove any remaining suspended material not removed during the clarification (Actiflo) process. The GAC also ~~provides adsorption capacity for removing~~removes dissolved organic matter, such as taste- and odor-causing compounds in the water.

The media in the filters is biologically active with bacteria colonizing the surfaces of the media. This is beneficial by allowing the removal of biodegradable organic matter (BOD) passing from the ozone basins. Removing BOM during filtration-adsorption will assist in controlling regrowth in the distribution system.

Periodically, the filter media will require cleaning to remove attached suspended material. Filter run time may ~~very ~~vary but at no time will an individual filter exceed 0.1 NTU prior to being backwashed. Generally, a backwash will be initiated on or before the SCADA NTU trend line begins to show a steady increase above the runtime baseline. The filter cleaning system includes a combination of air sour and water wash. Waste washwater is collected in the Equalization Basin adjacent to the Filters. Prior to bringing a filter back on-line, the filter is placed into filter-to-waste (FTW) mode~~ for several minutes – ~~for preconditioning until it~~'~~s turbidity is less than 0.1 NTU.

~~Deep Bed Dual Media GAC/Sand Filtration:~~
~~The heart of water purification is filtration. High rate dual media filters are composed of grains of sand and carbon but the filtering principal is not a straining action.~~ Without proper preconditioning, filters ~~will ~~may only remove the largest suspended matter from the water.~~ Smaller particulate matter must adhere to the grains of filter media or previously deposited material which explains the need for preconditioning.~~

~~In general, the same properties and forces that cause floc formation are needed for good filtration.~~ The ~~DOHS~~ DPH limit for ~~filter flow~~filter loading rate is 6 gpm/ft^2~~.~~ and is strictly adhered to by operations. This equates to a total maximum flow of~~Consequently, when operating at the permitted of flow~~ 30 MGD~~,~~ when all six filters ~~must be~~are in service~~;~~. ~~when a backwash is required, the influent flow must be reduced to 25 MGD prior to performing the backwash. When the filter is placed back in service the flow can then restored to 30 MGD.~~ All valves on the filters are operated through the SCADA ~~in the main control room~~system. ~~Rate-of-flow controllers are tied through a dedicated computer to the filter inflow rate~~ which also maintains desired filter effluent flows via filter effluent valve modulation.~~.~~

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Each filter has ~~a~~ head loss, flow, ~~rate~~ and turbidity transmitters sending information to the control room for display and documentation.

3.8 Post-Filtration Chemical Addition

After the water passes through the filter-adsorbers, it is collected in the filter effluent manifolds below the Filter Gallery. ~~At the end of the Filter Gallery, chemical feed connections are provided.~~ There are chemical injection points here where post-filtration addition of chemicals occurs. Sodium hypochlorite is added to provide a disinfection residual, caustic soda for pH ~~control~~adjustment, and polyphosphate for pipe corrosion. A pumped flash mix system is used to thoroughly mix these chemicals with the filtered water. Carbon dioxide solution is added to the filter effluent at a vault outside the filter structure~~. The carbon dioxide solution adds~~ which provides carbonate alkalinity to the treated water to help protect water distribution system pipelines and plumbing systems against corrosion.

3.9 Treated Water Reservoir

A 1.5-million gallon, completely buried concrete reservoir provides a limited amount of on-site storage of treated water. The reservoir serves as a clearwell and allows for flow differences between the plant production and the treated water pumping into the water distribution system.

3.~~9~~10 Treated Water Pump Station

The initial plant includes four 10 mgd capacity treated water pumps. The four vertical turbine pumps are set in cans. One of the pumps is equipped with a VFD to allow for flow rate adjustment. Normally, only three of the four pumps will be in operation at a time. The fourth pump is intended as a standby pump.

A fifth, empty can, is provided to add another pump in the future. Also, the four other cans are oversized to allow larger pumps to be used in the future when the plant is expanded.

The Treated Water Pump Station also includes two filter backwash pumps. Both of these pumps are equipped with VFDs. ~~Normally, o~~Only one backwash pump will be used at a time with the second serving as backup.~~; the other provides a standby unit~~.

3.11 Chemical Storage and Feed Facilities

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When new shipments arrive, prior to unloading~~ the chemical into the appropriate tank,~~ the operator will collect a ~~100 ml~~ sample directly from the tanker and conduct basic quality ~~procedures~~control analyses: color, specific gravity, pH, etc. This is to verify that the chemical being delivered is correct and not contaminated. ~~— prior to unloading.~~ The chemical, time of delivery and results of the quality control check are recorded in the Plant's Daily Operation Log. Once the chemical has been deemed to meet the related standards based upon the analyses, the delivery to the plant's storage tanks may commence. ~~–~~The ~~100 ml~~ sample ~~(collected from the chemical truck)~~ will be labeled, dated and stored for at least one month.

As part of the reliability and verification of the chemical feed equipment, each new shift rotation will ascertain that the chemical feed pumps are functioning ~~(~~according to SCADA ~~input~~ set points~~)~~ by performing a "pump catch" on every system that is in service. All data pertaining to performing this procedure, together with the ~~calculation~~ calculated dosage~~,~~ and/or any calibration or corrective action taken (such as calibration, stroke and/or speed adjust, changes to SCADA pump set points) ~~—~~shall be duly recorded in the Plant's Daily Operation Log. ~~-~~Furthermore, whenever the process shows signs of deteriorating~~,~~ a pump catch will be one of the first corrective actions conducted.

The following chemicals are available to be used:

Liquid Alum or Ferric chloride -- (two 13,000 gallon tanks)~~.~~
Sodium Hypochlorite (12%) -- (two 13,000 gallon tanks)~~.~~
Caustic soda (two 13,000 gallon tanks)~~.~~
Cationic polymer (dry or liquid)~~.~~
Anionic polymer (dry or liquid)~~.~~
Polyphosphate (tote bins)
Calcium Thiosulfate (tote bins)
Carbon dioxide (refrigerated tank)
Liquid oxygen (ozone makeup gas)

The **primary coagulant**, either liquid alum or ferric chloride, will be used to coagulate the raw water. Alum will be used initially as the primary coagulant. The coagulant is added at the Initial Flash Mix for efficient contact with the raw water. Coagulant is stored as a liquid in tanks located within the Chemical Building. Metering pumps transfer the material to the Initial Flash Mix via the Chemical Line Containment (CLC) System. The metering pumps have manual stroke adjustments and automatic speed control for flow pacing chemical based on ~~Raw Water Signal~~raw water flow.

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Cationic polymer is used as a coagulant aid for the Actiflo clarification process. High molecular weight cationic polymer is prepared using one of two Polyblend dry polymer batching systems located in the Polymer Room of the Chemical Building. A dry polymer is recommended for use with the Actiflo process. Polymer solution is pumped using metering pumps. The cationic coagulant aid is fed at the ~~Injection~~ injection~~Chamber~~ or maturation chamber of each Actiflo Basin.

Ozone provides the primary disinfectant at the SWTF. Ozone is produced using two 400-lb/day ozone generators located at the Ozone Generation Room in the lower level of the Operations Building. Liquid oxygen (LOX) is used as the feed gas for generating ozone. Gaseous oxygen (GOX) is produced at the LOX Tank using an evaporation system. GOX is conveyed to the Ozone Generator Room through a buried, pressurized pipeline. From the ozone generators, ozone is piped to the Ozone Contact Basins. Sets of ceramic diffusers at the bottom of the first cell of each contact basin are used to produce fine bubbles of ozone that transfer into the settled water from the Actiflo process. If additional direct contact is needed for ozone transfer, a second set of diffusers located at the entrance to the second cell of each contact basin can be placed into service.

Calcium Thiosulfate is provided to neutralize ozone residual that might be present in the ozonated water effluent prior to filtration. Ozone is corrosive and neutralizing the residual prior to the filter basin will prevent off-gassing. Calcium thiosulfate is stored in 220 gallon totes within the Polymer Room. The tote is connected to metering pumps which deliver the chemical to outlet cells of each ozone contact basin.

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Nonionic polymer is provided as a filter aid. When used,~~T~~his chemical can assist in optimization of particle capture in the filtration process. The primary point of chemical addition is at the final cells of the Ozone Contact Basins.

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Sodium Hydroxide (caustic soda) is provided for pH adjustment. This chemical is stored in liquid form within a storage tank located in the chemical building. Sodium Hydroxide solution is delivered to the application location by metering pumps. ~~-~~The pH of the water can be adjusted at three locations in the plant: Initial Flash Mix, the final cells of ~~the~~ each Ozone Contact Basin~~s~~, and the combined filter ~~water~~ effluent manifold.

Polyphosphate can be added to filter effluent prior to entering the clearwell. This chemical is used as a corrosion inhibitor. Polyphosphate is stored in totes which connect to metering pumps for delivery to the application point.

Sodium Hypochlorite is ~~provided for free chlorine disinfection~~used to provide a free chlorine residual in the Treated Water Reservoir and ~~residual disinfection~~ in the distribution system. It ~~is also~~can also be added for intermittent chlorination at various other locations in the plant. Sodium hypochlorite is delivered in bulk as a liquid and stored in tanks ~~at~~ in the Chemical Building. The hypochlorite is delivered to the desired application points using metering pumps. The primary point of application is at the filter effluent. ~~Secondary~~ Other injection points ~~disinfection locations~~ which are considered intermittent and infrequent are provided at the Initial Flash Mix and the Outlet Vault of the Treated Water Reservoir.

The **Chemical Truck Unloading Station** is located at the northeast corner of the Chemical Building to fill the liquid alum/ferric chloride, caustic soda, and sodium hypochlorite storage tanks. ~~At the station, the operator will be required to select the chemical tank that will be filled on a local control panel. The~~A control panel ~~will then~~ displays the levels in the tanks ~~to verify that it requires filling~~. When the operator selects start, the inlet valve will open and the ~~Delivery~~ delivery ~~Driver~~ driver can connect the hose to the proper fill ~~station~~ line~~and open the manual isolation valve~~. An alarm will sound at the station ~~at~~ when the tank HIGH level is reached to warn that the tank has been filled. Prior to physically receiving a load of chemical, the operator will collect a sample (directly from the tanker) and check its physical properties according to quality control guidelines.

A loading dock at the Polymer Room will allow delivery trucks to unload totes and sacks of dry polymer.

The Washwater Reclamation (Equalization) Basin~~:~~ provides equalization of the waste filter washwater. The 200,000 gallon basin is sized to store approximately two backwash volumes. Flow into the basin is pumped to the on-line Solids Drying Bed by ~~. The WWR Pump Station contains~~ two variable speed vertical turbine pumps, each rated at 415 gpm.

~~**Solids Drying Beds (Ponds):** i~~The initial plant construction include~~d~~s four unlined **Solids Drying Beds (ponds)**. Two of these ponds were lined in 2010 and the last two will be lined in 2012. As part of the lining project, improvements were made to add a chemical injection point prior to the entrance to the ponds to allow

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for cationic polymer addition to enhance settling in the ponds. This improvement was made to reduce the turbidity of the decant return water to meet the goals of the Filter Backwash Recycle Rule. Grab samples of the pond effluent are taken every four hours and the turbidity is measured and recorded. In addition, a Hach Surface Scatter 6 will be purchased in 2011 to provide continuous turbidity monitoring of the pond effluent.

Each pond has an operating capacity of approximately 1~~.0~~ million ~~-~~gallons. The ponds are used to settle out the solids ~~in~~ from the filter waste washwater and ~~the solids flow from the~~ Actiflo ~~Clarifiers~~clarifiers. The ~~Clarified~~ clarified water is decanted at the ~~Outlet~~ outlet ~~Structure~~ structure in each pond where it then gravity flows to the Decant Return Pump Station.

~~A~~ The **Decant Return Pump Station** includes two vertical turbine pumps with VFDs. Each pump has a capacity of approximately 625 gpm. The decant flow is conveyed to a connection with ~~Raw~~ the raw ~~Water~~ water ~~Pipeline~~ pipeline just downstream of the ~~Initial~~ initial ~~Flash~~ flash ~~Mix~~ mix orifice plate.

SECTION 4: Performance –Optimization

4.1 Treatment Optimization (Unit Process):

Jar tests, Filterability tests, particle count studies and Streaming Current Detector are the primary tools for conventional treatment optimization. Jar tests are performed on regular intervals or anytime treatment problems develop.
Jar tests are used as a plant model for flash mixing, flocculation and sedimentation. A series of jars are dosed with various concentrations of coagulants. Ganged mixers are set to mimic the agitation of a flash mixer for the period of time water would be in the flash mix chamber. The ganged mixers are slowed to imitate flocculation for a commensurate period of time. Then the mixers are stopped and the jars let stand to duplicate sedimentation. At the end of the settling period a sample is decanted and turbidity is measured for all 6 jars. An equal amount of sample from each jar is then filtered through six individual “pilot filters” to determine filterability. A jar test is only the first step. Treatment optimization is further achieved with full-scale plant trials. In addition, the Streaming Current Detector is excellent tool for detecting under- or over-dose of coagulant.

4.2 Streaming Current Detector (SCD):

A SCD is installed ~~parallel to the F~~downstream of the flash mix~~er~~ to aid in coagulant dosage determination. Colloids normally produce a negative surface charge. The particles repel each other continuously. This is called a stabilized condition. It is expressed as a negative number on the SCD. The dispersion of sufficient coagulant chemicals destabilizes the colloids allowing them to clump together to form floc. The SCD reading first becomes less negative, followed by neutral and will turn positive if too much coagulant is added. Optimum coagulant dose normally coincides with a SCD reading near zero.

4.3 Particle Count:

Particle count studies are done on a routine basis to document and monitor performance.
This will aid in improving efficiency of colloidal removal and help balance flow rates in various reaction vessels

4.4 *Cryptosporidium* Action Plan (see also Water Quality Parameters below): In accordance with HSC section 116360, the follow guidelines are used to optimize Treatment Plant performance for improved control of both disinfection by-products and microbial contaminants:

- Pre-Treatment Clarifier (~~effluent~~Actiflo) effluent 1-2 NTU
- Combined Filter ~~(effluent~~Effluent~~)~~ 0.1 NTU
- Filter-to-Waste 0.3 NTU (less than)

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Emphasis is placed on evaluating performance of each unit process as a separate distinct entity. To that extent, the particle counter is used to monitor and augment the turbidity target goals: to achieve optimum removal efficiency for each unit process.

SECTION 5: Reliability

5.1 Operational set points and alarms: *See Appendix*

Unit/Location	Set Point	SCADA Alarm
Primary Process Critical Alarms:		
Ozone Contract Basin Monitors	0.35 ppm	Low Level
(Dissolved ozone for CT compliance)	0.30 ppm	Low Low Level
	0.50 ppm	High level
Chlorine – Filtered & Treated Water	0.4 ppm	Low Level
	1.5 ppm	High level
Turbidity – Actiflo Settled Water	2.0 NTU	High level

Turbidity – Combined Filter Effluent	0.20 NTU	High level
	0.28 NTU	High High level
Turbidity – Individual Filter Effluent	0.08 NTU	High level
(all six filters)	0.10 NTU	High High level
pH at Treated Water	10.0	High level
	10.5	high level
Alum	Shutdown	High-High level
Polymer	Shutdown	High-High level

OZONE:

Ozonation Room:

Ambient Ozone	0.08 ppm	High level
Generator shutdown	0.3 ppm	High-high level
Oxygen	23%	High level
Generator shutdown	24%	High-high level
Ozone Destruct Ambient Monitors	0.1 ppm	High level
Generator shutdown	0.3 ppm	High-high level

Actiflo: (internal unit process)

HIGH effluent turbidity	2.0 NTU	HIGH level

HIGH TORQUE (Scraper Motor) 18,500 ft-lbs HIGH Level
HIGH TORQUE (shutdown) 22,000 ft-lbs HIGH high level

Secondary Process Alarms (partial list only):

Chem Feed Pumps: 95 PSI-Overload-Fail to run-Overspeed Common failure
Chem Storage Tanks: High level High level
Low level Low level
Low-low level Low-low level

Filters: 6 ft. Headloss
Elev. Filter channel flooded
Filter Gallery: Overload All filter MOVs

BW-tank Pumps: Overload-Low level-High pressure Common failure

Eq tank Elev.377.25 ft. High level
Eq tank Overflow Elev. 382.5 ft. High-high level
Eq tank Pumps Low level ___ ft. Common failure
Overload Common failure
Failure to run Common failure
Utility Water Pumps Overload Common failure

	Failure to run	Common failure
Engine generator	Failure to run	Failure
Clearwell	Elev. 379.0 ft	High level
	Elev. 362.0 ft	Low level

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Additional Information regarding ALARM verification and response:

In general, all critical alarms are checked and verified during scheduled calibration a~~. A~~t which time~~,~~ the sensor is exposed to a known standard greater than the alarm set point for SCADA. All results and corrective action are documented in the Daily Operator Log~~ and the Hansen Maintenance Program~~. ~~In addition, all alarms not acknowledged by the operator within 15 minutes will initiate SCADA to start an auto dialer sequence call out to the treatment plant's management for corrective action; any alarms triggering a "Low Low" or "High High" status will immediately initiate SCADA to start an auto dialer sequence call out to the treatment plant's management for corrective action. *See also section on "Chemical Feed Section".*~~

5.2 Power Failure and Emergency Power Operation Procedure:
When PG&E utility power is lost, the 200KW/250kVA diesel emergency generator is automatically brought on-line. The primary purpose of the generator is to provide emergency power for a SCADA controlled plant shutdown and other essential plant operations (such as lighting and additional backup power to SCADA controlled functions). It is not designed to operate high demand units such as the raw and treated water pump stations.

~~During regular working days and regular working hours, the operation staff will take immediate action to restore failing equipment. During off hours the Operator on duty determines, if no alternate units are available, whether additional assistance is needed. Emergency Call Outs must be done through the Employee on Stand by. For safety reasons, the Operator on duty is not allowed to conduct major repairs without backup personnel available.~~

SECTION 6: MAINTENANCE

6.1 ~~-~~Preventative Maintenance Program

~~:~~

~~The preventive maintenance software used by the City of Fresno is Hansen. The Hansen software program is a full-feature package including a security system, maintenance analyses, work order management, statistical predictive maintenance, audit trailing, warranty tracking and inventory control.~~Under direction of the senior operator, the plant Water System Operator II performs or attains outside services for all scheduled maintenance on plant equipment.

Every year~~,~~ the treatment plant will be shutdown for approximately one month~~,~~ to perform more extended maintenance that cannot be performed while the plant is online. At this time, such areas as filter media, disinfection system (including ozone diffusers), clearwell, pumps ~~&~~ and motors, etc will be inspected and all other major unit processes evaluated and/or repaired.

6.2 In-House Repair Capabilities

~~6.2~~ ~~:~~

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The City of Fresno's ~~maintenance~~ Water Division staff is capable of repairing most above ground electrical systems, mechanical equipment, and utilities ~~along with minor underground utilities~~. Instrument~~ation~~ calibration~~,~~ and ~~repair to PC board level and other repairs involving: cutting, welding, wiring, pipe fitting, disassembling, reassembling and installing are also within their scope of capabilities. Cost and Time comparisons are usually the determining factors in conducting repairs in-house or by using outside contractors.~~computer/SCADA programming and repair are also within the scope of work for City staff.

Major underground pipeline and electrical utilities, machine work and instrumentation repair will be carried out with the assistance of contractors.

SECTION 7: WATER QUALITY PARAMETERS:

Disinfection and CT calculation:

Disinfection is the final barrier to preventing viable micro-organisms from entering the treated water supply. Primary disinfection is achieved with ozone. The Surface Water Treatment Rule (SWTR) sets the minimum disinfection requirements utilizing the CT concept. For compliance reporting purposes, ozone is measured (Hach Ozone Colorimeter ~~-~~#58700-04) at ~~the end of~~ the bottom (entrance) of cell #2 and the top (exit) of cell #4 in each Ozone Contact Basin. To maintain compliance with disinfection requirements, the ozone residuals need to~~:~~

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meet~~ing~~ or exceed~~ing~~ -0.3 mg/L and 0.1 mg/L at the respective ~~locations~~sample points.

~~Based on~~With the controlling parameter being viruses, sample data for ozone residual and temperature are entered into a computer program for generating the CT ratios every four hours. The CT value selected for the day will be that ratio obtained during peak hourly flows. After applying the appropriate log credit (for conventional treatment), it is determined that this plant will meet or exceed the ozone residual required for SWTR compliance. ~~As the water leaves the contact chamber and heads for the filters, any ozone that off gases while in the final chambers of the ozone system is collected and sent to the ozone destruct unit. Prior to the water moving on to the filters, any remaining ozone is neutralized with calcium thiosulfate and the pH adjusted to around neutral with sodium hydroxide.~~

Turbidity:
To promote the removal of Giardia Lamblia cysts and Cryptosporidium, the target turbidity of our finished water is 0.1 NTU or less. So that the operator is aware when any one filter reaches 0.1 NTU, ~~-~~the individual filter effluent alarms are set at 0.08 NTU ~~and~~ which will prompt the operator ~~can~~ to take corrective action.

Corrosion Control:
Corrosion control is accomplished through the addition of carbon dioxide and sodium hydroxide~~adding Carbon Dioxide and through pH adjustment of the treated water with Sodium Hydroxide~~. The final pH is based on an engineering study ~~(~~recommending a target pH of approximately 9.0~~)~~ and by ~~using the~~regular Aggressive Index (AI) calculations.

Odor:
Threshold Odor Number (TON) analyses are conducted twice per day. When the filtered water TON reaches 2 operators will investigate the cause and take corrective action. (Odor problems are the most difficult to pinpoint and the sources not always found).

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Bacteriological:
R~~Both R~~aw, combined filter effluent, and ~~Treated~~ treated water are tested twice daily, using the MMO-MUG Colilert procedure. In addition, Distribution System samples are collected according to the Coliform Monitoring Plan from those selected locations known to represent treated surface water from the Treatment Plant.

Laboratory Analyses (performed by an outside laboratory):
Laboratory staff conducts the following analyses on Raw and Treated water.

1. HPC - once per week
2. Color - Once per week
3. DBPs: TTHM and HAA5s - once per month, Treated water only
4. Regulated and Unregulated Organics - once per quarter, Raw water only.
5. Title 22, General Minerals, Inorganics, VOC (regulated and unregulated)-once
   every year; SOC's once every three years.
6. ~~6.~~ Crypto / Giardia - once per month

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~~**NOTE:** For the *first year of operations*, the "Water Quality Monitoring Schedule – Source Water" mandated by DOHS will be followed:~~

~~1. Primary inorganics (cyanide being waived) = once / 12 months~~
~~2. Asbestos = once/9 years~~
~~3. Secondary Standards (except thiobencarb) = once / 12 months~~
~~4. General Mineral = once / 12 months~~
~~5. VOCs (including MTBE) = 4 consecutive quarters, then annual~~
~~6. SOCs:~~
   ~~a. Alachor = 4 consecutive quarters, then 2 quarters/36 months~~
   ~~b. Atazine = 4 consecutive quarters, then 2 quarters/36 months~~
   ~~c. 2,4-D = 4 consecutive quarters, then 2 quarters/36 months~~
   ~~d. Endothall = 4 consecutive quarters, then 2 quarters/36 months~~
   ~~e. Simazine = 4 consecutive quarters, then 2 quarters/36 months~~
~~7. Other:~~
   ~~a. Boron = One sample, if ND, no further monitoring; if detected 3 additional quarterly samples.~~
   ~~b. Chromium 6 = only if chromium > 1ug/l, 4 consecutive quarters (raw and treated).~~
   ~~c. Ethyl-tert-butyl-ether = If MTBE detected, 4 consecutive quarters~~
   ~~d. Perchlorate = If water system has nitrates > ½ MCL, 4 consecutive quarters.~~
   ~~e. Tert-Amyl-methyl-ether = If MTBE detected, 4 consecutive quarters~~
   ~~f. Vanadium = One sample, if ND, no further monitoring; if detected 3 additional quarterly samples.~~
~~8. **Radiological:** Gross Alpha & Radium 228= 4 quarters (*see regulations for when gross alpha is greater than 5 pCi/L or when ND results are obtained for first two consecutive quarters*).~~

Water Quality Records:

A Daily Log sheet is used to record water quality test results. Analyses~~,~~ that are performed every 4 hours by plant personnel include: turbidity, ozone / chlorine residuals and pH on raw~~-~~, ~~conditioned~~settled~~-~~, filtered,~~-~~ and treated water samples. CT ratios are calculated every four hours and recorded on the daily log sheet. Water quality analyses that are conducted twice per day include: odor, alkalinity, hardness. chlorides and conductivity. Bacteriological test are performed once per shift on raw and treated water and recorded on a special Bacteriological Report sheet. It is based on this Daily Log Sheet that other administrative data is generated: cost of production, chemical inventory, etc.

Operation Records:
In the control room, the operators maintain a bound ~~Journal~~ journal ~~Of~~ of ~~Plant~~ plant ~~Operations~~ operations in which a written record is maintained of any and all significant events that occur during the ~~-~~daily operation on the SWTF: flow changes, calibration of inline monitors, chemical dosage changes, equipment repairs, etc. This ~~Journal~~ journal also includes any process or equipment failure, date and time of such incidents, and the corrective / preventative action taken. In addition, SCADA collects and maintains a history of all inline process analyzers (pH, turbidity, particle counters, temperature, ozone and chlorine analyzers, etc) pump changes, set points and run times, numerous flow totalizers, a digital and hardcopy alarm log, filter performance/runtime, etc. This is augmented and validated by data logs of~~:~~ lab results (mentioned prior), ~~run time hours on equipment~~equipment runtimes, ~~-not included in the SCADA program~~ and the inventory of remaining chemical stocks which are calculated and recorded daily. Basic production data recorded will include: quantity of water produced, plant flow rates, filtration rates, backwash rates, hours of operation, chemical usage and dosage, dates of filter maintenance and inspections, etc.

Response Plans: Any event that occurs at the treatment facility which results in loss of process control and/or violates regulatory standards will result in the facility being shutdown and the City well system adjusting. The operator on duty will follow the procedures outlined in the Plant Shutdown SOP and make further notifications as the situation requires. This includes all events including, but not limited to, treatment plant failures, power outages, and watershed emergencies.

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~~**Response Plans:** Any event, that occurs at the treatment, which results in loss of process control and/or violates regulatory standards will result in the facility being shutdown and additional wells placed into service as needed. The operator on duty will notify the senior and Chief of Water operations (if not already having done so) and if necessary the water quality superior and other departments as directed). This includes all such events as but not limited to: treatment plant failures, power outages, and watershed emergencies.~~

APPENDIX

EMERGENCY PHONE NUMBERS

LOCAL: 911

~~Day~~ Office Phone ~~Night~~ Cell Phone

STATE:

~~DOHS~~DPH, Carl Carlucci, Fresno 559-447-3132 (b) (6) [redacted]

DPH, Kassy Chauhan Fresno 559-447-3316

~~DOHS~~DPH, DHS Duty Officer, Emergency Services 800-852-7550 800-852-7550

CAL. OSHA, Fresno 559-445-5302

City of Fresno's MANAGEMENT STAFF:

Chief of Water Operations (b) (6) [redacted] (b) (6) [redacted]

~~Chief of Water Operations~~ (b) (6) [redacted]

Water System Supervisor (Senior Operator) (b) (6) [redacted]

Water System Manager (b) (6) [redacted]

Operational Procedures

Before attempting to operate the raw water facilities equipment in any mode, the plant operator should be thoroughly familiar with the purpose and descriptions of the components presented in the preceding pages. This includes all pertinent safety considerations ~~and with the respective~~as well as manufacturer ~~equipment manufacturer's~~ and plant O&M instructions. In addition, ~~-~~ ~~the~~ the plant operator should ~~review~~ be familiar with the Material Safety Data ~~Safety~~ Sheets and know the precautions, health hazards, first aid, and required protection for handling the chemicals used at the SWTF.

The start-up and shutdown procedures for the raw water facilities are presented below.

~~.~~ **NOTE:** The sequence of events presented herein should occur regardless of mode of operation. *Special consideration should be given when operating in manual mode.*

Start-up Procedures

~~Fully read these procedures and other referenced procedures prior to beginning start-up.~~

1. Start the raw water ultrasonic flowmeter

a. Ensure that isolation valves upstream and downstream of the Raw Water Meter is OPEN.

b. Verify that the meter is powered-up, and the signal successfully transmitted to the PCIS.

2. Ensure the Raw Water Pumps are ready for operation

a. ~~a.~~ On the discharge of each pump, ensure that the shutoff valves at the pressure gauges, pressure switches, and air vacuum/air release valves are open.

b. ~~b.~~ Ensure the isolation discharge valve for each pump is OPEN.

c. Ensure the position of the motor starter breaker for each pump is ON.

d. Ensure Raw Water Pump Station VFD/MCC's are ready for operation.

i. Verify that intake pumps are on remote, are ready and that no faults have been detected.

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ii. Verify Lead/Lag designation of individual pumps.

3. Ensure the downstream process train is ready for operation

a. Ensure the Actiflo Basins are ready to receive water. If the basins are empty, initial raw water flow set-point should be approximately 4 mgd until the basins are filled.

i. Ensure manual isolation valves (3-V-11 & -21) upstream of the Actiflo Basins are open.

ii. Ensure the Aciflo Effluent Valves (3-MOV-11 and & -21) are closed. (During start-up of the Actiflo Basins, the effluent will initially diverted via the 36" PO pipeline to the suction of the Raw Water Pumps.)

b. Check the applicable chemical metering pumps are ready for remote operation from a PCIS workstation. Check the pump settings and enter the desired dosage set-points before start-up.

c. Ensure Ozone system has been activated and ready to receive water (see SOP for detailed instructions for both "manual" and SCADA). For remote Start-up verify at least:

i. No Interlocks

ii. LOX Tanks are operational

(1) LOX valve is opened

(2) At least one Vaporizer discharge valve must be opened.

iii. N2 is in "Remote/Auto" with % Set-up

iv. Generator PSU in Remote

v. Ozone feed Control valve, Contactor, Off Gas Value, Destruct valve -- all in Remote

(1) Appropriate destruct isolation valve open and related temperature control panel set to -35 ° F

vi. From SCADA set

(a) Dosage setpoint

(b) Start Destruct and nitrogen units

(c) From SCADA: Start Gas Flow at the PSU, open Gas Flow Control Valve, set cooling water at PSU, verify all related unit process are functioning properly

(2) Start PSU from SCADA and verify system operation

vii. Dissolved O3

(1) Monitor operational

(2) Sample point selected

(3) Sample flow established

4. Start the plant process train

a. Manually start the appropriate sample pumps and associated instrumentation. Refer to the manufacturer's instruction manual for setup and calibration procedures.

b. Start the Actiflo Process (See Actiflo Start-up/Fill Procedures in Section 3). Start-up of individual components of the Actiflo process will be sequenced by the US Filter/Kruger Control Panel PLC.

c. At an operator workstation, start the appropriate chemical metering pumps (See Chemical Feed Facilities Start-up Procedures in Section 7). Start the metering pumps in a sequence that allows for the lag time required for the water to reach the various application points in the process train.

d. At the operator workstation, enter the initial raw water flow setpoint and start the Raw Water Pump(s). Again, the initial flow rate should be limited to about 4 mgd if the downstream basins are not full (otherwise, startup at 7 mgd).

e. After the basins are full and water begins to spill into the effluent channel, increase the plant flow rate in approximate 2 mgd steps every 5 minutes until the desired flow rate is achieved.

f. Once the desired flow rate is achieved and the settled water turbidity reaches 2 NTU or less, open the Actiflo Effluent Valves to allow flow into the Ozone Basins.

Shut-down/Draining Procedures

1. Shutdown plant flow.

a. At the operator workstation, request Raw Water Pumps to Shut-down.

b. Sequence through shutdown of process equipment in reverse order of start-up.

c. If long-term shut-down is anticipated, manually shut-down all applicable sample pumps and instrumentation.

Alarm/Abnormal Operations

- LOW and LOW-LOW level at the Raw Water Pump Station as determined from the level signal shall provide alarm indications to the PCIS operator workstation to alert the operator.
- Pump FAIL alarm status input shall be transmitted to the PCIS for indication at the operator workstation.

The PCIS will also generate a pump FAIL alarm if a pump is called to run and no pump run status is received within 30 seconds.

SCADA Alarm/Abnormal Operations

(see appendix for a more detailed list)

A PCIS alarm will activate under the following conditions:

- HIGH Influent Turbidity
- HIGH or LOW Influent pH
- SCM charge UNBALANCED
- HIGH effluent turbidity
- HIGH OR LOW effluent pH
- Seal water LOW flow
- HIGH sand pump pressure, LOW sand pump pressure
- MOTOR FAILURE of the Coagulation Mixer.
- MOTOR FAILURE of the Injection Mixer.
- MOTOR FAILURE of the Maturation Mixer.
- MOTOR FAILURE of the Settling Scraper.
- HIGH TORQUE on the Scraper Motor
- Microsand Recirculation Pump HIGH or LOW pressure
- Microsand Recirculation Pump MOTOR FAILURE

ACTIFLO SOP

BACKGROUND

Two 10 MGD ACTIFLO trains
- Coagulation tanks with mixer
- Coagulant Dispersion – Inline injection
- Injection tanks with mixer
- Maturation tanks with mixer
- Settling tanks scraper
- Microsand recirculation circuits
- Dry Polymer preparation and feed system
- PLC Based Control and Monitoring System

Influent
- Monitoring
  - ➢ Streaming Current Monitor
  - ➢ Influent Water Flow Rate
  - ➢ pH
- Chemical Injection
  - ➢ Coagulant – Aluminum Sulfate (Alum)
  - ➢ Polymer – Magnafloc LT22S
- Post Chemical Injection Monitoring
  - ➢ pH

Coagulation tank
- Detention Time: 2.2 minutes at 10 MGD
- Coagulant is added in the raw water line prior to entering the coagulation tank
- Monitoring
  - ➢ Mixer Status
  - ➢ pH
- Mixer: 7.5 HP
  - ➢ 45 rpm
  - ➢ Constant Speed

Injection Mixer
- Detention Time: 2.2 minutes at 10 MGD.
- Addition of microsand and possibly polymer
- Monitoring
  - ➢ Mixer Status

- Mixer: 7.5 HP
  - 45 rpm
  - Constant Speed

Maturation Tank

•Detention Time: 7.1 minutes.
•Lower mixing energy to complete floc formation and promote particulate contact
•Monitoring
  ›Mixer Status
•Mixer: 10 HP
  ›25 rpm
  ›Variable Speed
  ›User defined constant operating speed
  ›Once set generally will not change
  ›Never run mixer without the scraper and sand pump(s) operating

Settling Tank

•Rise Rate: 20 gpm/ft^2
•Sludge Scraper: 2 HP
  •Variable speed, user defined speed settings
  •Once set generally will not change
  •Continuous operating torque – 18,500 ft-lbs (**alarm**)
  •Cut-out torque – 22,010 ft-lbs
•Lamella Tubes: Captures finer particles, completes clarification
•The sludge scraper shall not run without a sand pump already running and functioning properly.
•**Monitoring**
  ›Scraper Status: high torque, motor status, high torque **fail**
  ›Effluent Turbidity: **Alarm** issued when high turbidity detected

Microsand / Sludge Recycle

- **Slurry Pumps**
  ›Constant Speed
  ›Discharge Pressure: 37 - 38 psi
  ›Rubber Lined for Slurry application
  ›Monitoring:
    ›Pump Status
    ›Pressure Switch to shutdown pump in event of high or low head condition and activate **alarm** via PLC
    ›Seal Water flow
  ›1-duty and 1-stand-by pumps

Hydrocyclones

- ➢Separates Microsand from Sludge
- ➢Rated at approx 80% overflow / 20% underflow
    - ➢overflow (sludge)
    - ➢underflow (microsand return)
- ➢Inlet pressure approximately 25 psi

PLC Control System

- •Monitors and Controls Equipment
    - ➢Status: Run, Stop, Failure
- •Issues Alarms
    - ➢Equipment failure: Mixers, pumps, etc.
    - ➢Automatic selection of stand-by microsand pump if there is a primary pump failure
    - ➢High/Low Pressure on microsand recycle
- •Controls Process
    - ➢Automatic Start-up and Shut-down
    - ➢Remote start (AUTO)
    - ➢Local start (HAND)
    - ➢True manual mode
- •Monitors Mechanical Equipment
    - ➢Motor Failures
    - ➢Overcurrent, etc.

Plant Operation

Preliminary Verifications

- √Equipment
    - √Make sure all equipment is in AUTO at the local / remote switches and power is on at the MCC
    - √Make sure there are no active alarms on the PLC
- √Chemicals
    - √Make sure there is an adequate quantity of coagulant and polymer onsite and that the polymer has been activated
- √Make sure all tanks are full of water
- √Instrumentation
    - √Make sure all ACTIFLO instrumentation is operating as designed
- √General
    - √Make sure no visible obstructions are in the process tanks and hydrocyclone recirculation circuits

Mixers

- Coagulation and injection tank mixers
  - Operate at a constant speed during typical operation
- Maturation tank mixers
  - Operate at a lower speed to provide gentle mixing
  - Variable speed mixer
    - Once set generally will not change
    - High speed mixing in the maturation tank may cause the floc particles to shear
    - Low speed mixing may not provide sufficient mixing or enough energy to suspend the floc particles
- Failures in either the maturation or injection tank mixers will initiate the shut down sequence, a coagulation tank mixer failure should not cause a shut down
- Check oil levels and grease
- Check for visual obstructions or other irregularities
- Dents
- Obvious misalignments
- Wiring
- Excessive vibration during operation
- Mixer shaft and impellers
- VFD operation (for the maturation tank mixer)
- Etc.

Scraper

- Collects sand/sludge floc particles that settle to the bottom of the setting tank
- Variable speed based on the influent flow
- Periodically check scraper torque
- Scraper will shut down on a high-high torque **alarm** ("cut-out" 22,010 ft-lbs)
  - **Alarm** torque: 18,500 ft-lbs
- A scraper failure will initiate the shut down sequence

Microsand Recirculation Circuits

- Typical operation is to run one circuit per train with a stand-by circuit
- Pump will shut down on:
  - High or low discharge pressure
  - Loss of seal water
- If the primary (duty) pump fails the PLC will automatically select the stand-by pump
- If there are no available sand pumps all ACTIFLO equipment will shut down
- ✓Pump discharge pressure (35 – 40 psi)
- ✓Hydrocyclone inlet pressure (20 – 25 psi)
- ✓Conical hydrocyclone spray
- ✓System microsand concentration

Seal Water Stations

- ✓All slurry pump shafts are protected from sand intrusion on the shaft by packing rings
- ✓Packing rings are lubricated with a seal water flush
- ✓Typically flush requirements are 1.0 – 0.5 gpm
- ✓Sand is additionally kept away from the shaft and packing by a Spiral Trac™ bushing

•Monitored daily by Operator

- •Large "window" will provide satisfactory performance. Typically 3 to 6 g/L
- •Concentration too low: high effluent turbidity
- •Concentration too high: Underflow from cyclone "ropey" or thick rather than cone shaped spray
- •Consumption generally ranges from 7 to 12 lbs per million gallons treated
- •Sand added by operator. Frequency typically once per week or less

Sand Concentration

- •Calculate Sand Concentration in underflow according to following formula

Sand Concentration

- •Calculate Sand Concentration in tanks

Suggested Sand Concentration Monitoring

- ▪Obtain Cm values based on an average of 3 catches per hydrocyclone in operation
- ▪Obtain 3 separate Cm values over a 24 hour period to develop a daily average

Coagulant Dosing

- ➢Typically acidic and corrosive: Handle properly
- ➢Dose in mg/L input by Operator or dose can be controlled manually
- ➢Controller will maintain required dose as flow varies by pacing metering pump speed accordingly

Coagulant / Chemical Dosage Calculations

Polymer Dosing

- ➢Automatically activated by a polymer preparation system or through manual preparation
- ➢Very Slippery when spilled.
- ➢Categorized by charge (+,0,-), intensity of charge, and molecular weight
- ➢Do <u>NOT</u> mix cationic (+) and anionic (-) polymers
- ➢Desired dose is input into the PLC by Operator
- ➢Controller will maintain required dose as flow varies by pacing metering pump speed accordingly

Startup and Shutdown

- Required sequence of starting or stopping of individual equipment prevents accumulation of sand in settling tank and purges sludge recirculation lines
- Typically sequence initiated by Operator via PLC. PLC controls sequence
- Can be performed manually by Operator

Treatment Objectives

- Removal of turbidity, suspended solids and other parameters from the influent raw water
- Efficient usage of chemicals
- Proper maintenance of ACTIFLO equipment

ACTIFLO Optimization

- The process used to identify and select the process variables and operating
- parameters which give the best ACTIFLO performance
- Typical Process Parameters & Variables
  - Flow Rate
  - pH
  - Coagulant type and dose
  - Polymer type and dose
  - Temperature
  - Time of day, week, month
  - Etc.

Performance Criteria For Optimization

- Parameters monitored could include:
  - Turbidity
  - TOC
  - Color
  - TSS
  - Etc.

Process Considerations

General

- Verify proper operation of all ACTIFLO related equipment, instruments, chem. feed, etc.
- Change only one variable at a time
- Wait a minimum of two HRTs before recording data or making another change
- Record influent water data and performance for future reference when similar conditions exist

Insufficient Polymer Dose

- Coagulated particles in the raw water will not fully attach to the microsand to
- enhance settling and may result in carryover into the settling tank

- Generally you will not see a well defined floc in the maturation tank
- "Pin" floc carryover in the settling tank

Insufficient Influent Water Coagulation

- Raw water particles not fully destabilized resulting in decreased settled water
- quality
- Cloudy appearance in the settling tank
- Clear "ribbons" or "marbling" not seen in maturation tank

Low Microsand Concentration

- High Effluent turbidity
- Clear "ribbons" or "marbling" not seen in maturation tank
- Lower floc density in the maturation tank

Process Optimization Suggestions

- Plot the effect of a process variable on ACTIFLO performance
- Identify and select the "Optimum" setting for the variable being investigated
  - This will be the point on the curve where the slope of the curve changes or where the curve begins to plateau.
- Make small changes in the chemical feed rates 5 – 10 mg/L (coagulant) and 0.1 mg/L (polymer) around the initial value and evaluate the effect

Equipment Maintenance

- Lamella Tubes
- Mixers
- Sand Recirculation Pumps
-

Equipment Maintenance

- Lamella Tubes
  - Twice per shift: Visual walk through

  - As required: Partially drain tanks and wash down tubes to remove sludge accumulations. Typically required once every few weeks. Frequency will depend upon influent water quality, influent flowrate and dosages for coagulant and polymer.
  - Follow procedures in the process O&M manual

Equipment Maintenance

- Mixers
  - Twice per shift: Visual/Auditory walk through
  - Once per Month:
    - Check gearbox oil level

            - Check external airways on motors for obstructions
        - Once every 6 months
            - Change gearbox oil and grease Bearings
            - Close-up Inspection of seals for leaks
        - Once Per Year: Inspect impeller and shaft
    - As required:
        - Tighten terminal and bolt connections
        - Touch up painting
        - Seals: Typically every 3-5 years

None of the information in this presentation is intended to supersede information in the Operation and Maintenance Manuals

Jar Testing

- Bench scale test of ACTIFLO process
- Single jar test beaker is set up to replicate the ACTIFLO process
- Useful in determining
    - Chemical dosages
    - Chemical types
    - Starting point for process optimization
    - Etc.

Ozonia North America

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491 Edward H. Ross Drive
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TEL: (201) 794-3100
FAX: (201) 794-3358

DRAFT

April 23, 2004

Fresno, CA

Ozone System Start Up

Utilities Check

1. LOX available in one of the LOX tanks
2. Power available
   a. All 480 VAC breakers to the operational equipment are closed and operational
   b. All lighting circuit breakers to the operational 120 VAC equipment are on and operational
3. Water is available
   a. Process water is ready for use
   b. Cooling water is ready for use
4. Quenching agent available

Equipment

1. Equipment manual isolation valves – The individual pieces of equipment in the system must be ready and available for use. There are manual isolation valves for all the equipment to allow for the unit to be taken out of service. Normally these manual isolation valves are in the open position for equipment that is available for service. Operations must be sure that these valves are open. If a manual isolation valve is closed on a piece of equipment and there is an attempt to start the equipment, the system may attempt to start up and then shut down. Putting the Ozone equipment in Local or Hand will show unavailability at the SCADA screen. Putting the Ozone

equipment in Remote and Auto shows availability and allows the Automatic system to use this equipment.

2. LOX tank
   a. Liquid draw valve open
   b. Economizer valve open (if applicable)
   c. Pressure building coil valve open (if applicable)
3. Vaporizers – Local control panel operational with one solenoid valve open
4. At least one contact basin is filled with water
5. Diffusion – Each contactor has two cells to receive Ozone gas. There are manual isolation valves to each cell with diffusers, a gas flow adjusting valve is adjacent to the rotometer. Plant operations must decide how much gas will go into each cell and adjust the gas flow accordingly.
6. Pressure regulating valve in LOX area is properly set
7. A source of Nitrogen for the system. This is normally the N2 skid. Bottled N2 free of hydrocarbons is acceptable.
8. One particulate filter is operational and in service.
9. Dewpoint for the system is good in order to make O3. Gas can pass if dewpoint is not good.
10. Generators have remained pressurized or are in condition to run i.e. internally they are dry.
11. Destruct units have been drained of condensate
12. Destruct unit differential temperature controller setpoint is 30 - 40 deg. F. This can only be done at the controller at the panel.
13. All safety systems are operational
    a. Ozone leak detection panel (when available)
    b. Ozone and Oxygen ambient monitors
    c. Ventilation
14. Instrumentation and monitors on equipment is available.
15. Cooling water, sample pumps, and chemical feed pumps and other equipment available.

Process

1. The choice of equipment to be used must be made and in some cases lead/lag equipment must be chosen.
   a. The vaporizers equipment in Auto/Remote are suppose to alternate according to the set time in their cycle.
   b. Particulate filter
   c. Generator
      1. Lead/lag
      2. Local/remote start/stop
      3. Local/remote power setpoint

4. Manual/Auto Power Setpoint control
5. Electric valves for water/gas – remote/Auto

d. Nitrogen must be available
e. Cooling water system equipment
    1. Cooling water pump/equipment
    2. Cooling water discharge location
f. Contactor
g. Contactor Cell and Rows of diffusers.
h. Destruct
    1. Auto/manual start/stop operation
    2. Auto/manual contactor pressure control
    3. Auto/manual contactor selection for pressure

2. Processing parameters must be chosen
    a. Plant operating mode
        1. Constant Concentration in Auto
        2. Constant Concentration or % power in manual
    b. Raw Water Flow Control
    c. Type of operation
        1. Complete automatic operation
        2. Manual operation (Semi automatic operation is a part of manual operation)
    d. Ozone Feed Control
        1. Ozone feed control from the Header Valve
    e. Contactor Control
        1. Location of Ozone injection
            a. Choosing the diffusers to be used at the injection point
        2. Dosage
            a. Initial dosage setpoint
        3. Residual

Interlocks – There are five items that must be satisfied to allow the plant to run and make Ozone. If they are not satisfied then the system will not begin to start or if it does begin to start will not complete the start. If one of these interlocks appears during normal operation, the Ozone system will shut down, the interlock satisfied and will have to be re-started.

1. No High-High Ambient Ozone or Oxygen alarms
2. There is no High-High Vent Ozone alarm condition
3. At least one Destruct unit must be running
4. At least one Contactor must be selected
5. Gas dewpoint must be less then –76 deg. F.
6. See other notes below

Further discussion on interlocks.

1. Ambient Ozone and Oxygen alarms. There are two alarm conditions with each type of ambient monitor. The low alarm is set at 0.08 ppm Ozone and 23% Oxygen. As the level of O3 or O2 increases to this level alarm lights will turn on and horns will sound (forthcoming). This alarm is not a shut down for the plant. This alarm will continue until the level of gas goes below the alarm level AND the reset button at the Leak Detection Panel. At that time the alarm lights will stop. The second alarm condition (high-high) is set at 0.30 ppm Ozone and 24% Oxygen. At those levels the alarm lights will come on, horns will sound, the Ozone generators will shut off and not produce ozone and the system will shut down. The system cannot be started if there is a High-High Ambient Ozone OR Oxygen alarm. The horns can be silenced by pressing the "silence" button at the Leak Detection Panel. The system will stay shut down, alarm lights lit. When the level of the leak goes below the high- high level the system could be re-started but the alarm light will continue until the alarm condition goes below the low level AND the reset button at the Leak Detection Panel is pressed.
2. The discharge from the system destruct units is monitored for Ozone. There is a restriction on the amount of Ozone that can be discharged into the atmosphere. At this time a high level alarm is set to 0.1 ppm Ozone and the high-high level shutdown is 0.3 ppm Ozone. Thus if the level of Ozone gas discharged reaches 0.3 ppm Ozone, the system will shut down and will not be allowed to re-start until the level goes below the high-high alarm point.
3. One destruct unit must be in operation to make Ozone. If the plant is to start from a 'dead' start a unit will be off. The first thing will be to start a destruct unit. If the plant is to be operated in 'manual', the unit must be started before the generators will be allowed to run.
4. A contactor basin must be selected to allow a path for the Ozone gas to get to the destruct unit. This basin must be selected before starting the sequencing. This basin can be selected at anytime prior to passing gas when the system is run in 'manual'
5. The dewpoint in the gas stream must be lower then –76 deg. F to start up the Ozone system. Higher then this level can cause damage to the equipment. Higher then this and the O2 can still pass
6. Other notes
   a. The LOX valve is the responsibility of the operator to check to see that this valve is available and open when needed.
   b. As a general note: there is a Low Temperature Switch at the discharge of the vaporizer. It is unknown as to its function as of 5/04.

Remote Start up

1. No Interlocks
2. LOX Tanks operational
3. LOX valve opened
4. At least one Vaporizer discharge valve must be opened.
5. N2 skid is in Remote/Auto with a % setpoint. Watlow Controller at the Local Panel must be in Remote
6. Generator/PSU (Read Imalog Document Ozone Generator Control System Operations and Maintenance Manual for Generator/PSU details)
   a. Staging - must select a lead/lag generator (if applicable)
   b. Generator electric gas and water valves must be in remote at the valve
   c. One Cooling water discharge valve at the basin must be open
   d. PSU must be in Remote at the PSU
   e. Generator Control (SCADA)
      1. Concentration setpoint installed unless the PSU is to be run in %Power, then the controller at the PSU must be placed in Manual
7. Ozone Feed Control
   a. Feed valve in remote at the valve.
8. Contactor
   a. Choose the contactor(s) to be 'in service' at SCADA.
   b. Go to the balance valve of that contactor and adjust accordingly (Rotometer at side of contactor).
   c. Go to the Off Gas Valve of that contactor and put it in remote
9. Destruct
   a. Open the manual isolation valve to the destruct unit to be used. Close the manual isolation valve to the destruct unit not to be used. This is a manual operation and if not done, gas can be sucked through the unused unit and can destroy the catalyst material.
   b. At least one destruct unit is in Remote at the local Destruct Panel
   c. Set the temperature controller at the local panel to –35 deg. F. This is the differential the heater will be controlled to.
   d. Pressure Control Loop – install a vacuum setpoint at the SCADA screen. This will be normally be –3 or –4 inches of water.
   e. Note – if there is a destruct failure, the operator will have to go to the destruct units and manually close/open isolation valves before turning on the other unit.
10. Plant
    1. Raw Water Flow
    2. Set the Dosage Setpoint at the SCADA screen

11. Dissolved O3
    a. Monitor operational
    b. Sample point selected

   c. Sample flow is established
12. Start the Destruct unit from the SCADA screen
13. Start the N2 from the SCADA screen
14. Start Gas Flow at the PSU from the SCADA screen
15. Open Gas Flow Control Valve from the SCADA screen
    a. There should be a 2-5 minute pre-purge time before making O3
16. Install a set point for cooling water flow for the generator (71 gpm) and the PSU (15 gpm). Start cooling water at PSU for Generator and PSU. This is done from the SCADA screen
17. Verify destruct unit operation and vacuum at the basin from the SCADA screens
18. Verify the gas flow split to the basin cells on the rotometers
19. Start the PSU from the SCADA screen
20. Observe operation and adjust accordingly
21. Apply quenching as required

Remote Stop

1. Stop the PSU from the SCADA screen
2. After 5 minutes stop the gas flow at the PSU from the SCADA screen – this is the post purge and will rid the generator from most of the O3
3. Check to see that the N2 flow went to zero. If it did not, give it a 0% command from the SCADA screen
4. After 5 more minutes shut off the cooling water flow from the SCADA screen – this gives time to cool the generator and power supply
5. Shut the flow control valve from the SCADA screen
6. Turn off the destruct unit from the SCADA screen – this should force the Off Gas Valve to shut, if it does not, shut the off gas valve
7. Turn off other equipment as required.
8. The operator will decide if it is necessary to shut the manual isolation valves to the equipment

Changing equipment/bringing on a second unit remotely

1. Generator/PSU – If a second generator is to be brought on line, power to the first unit should be brought down to approximately 50%, the gas valve to the second unit opened, gas flow increased to the prescribed level, the first unit can be re-powered and the second unit turned on. This will prevent the first unit from making more then 12% O3 when the gas flow split is made. This would be a manual function. A second option would be to increase the gas flow to 150% of the original setting, opening the lag generator's gas flow valves, increase the gas flow to the prescribed level and then turning on the lag generator. This again is a manual function

2. Destruct Unit – Each destruct unit is a 100% unit and can handle the gas flow from two generators. To take one out of service and bring another into service, open the manual valve to the unit not running and turn it on. Immediately go to the running unit and shut if off. When it shuts down, close its manual isolation valve. Note, if check valves are installed in the discharge of each unit, the manual isolation valves can be left open for normal operation and then the lag unit can be remotely started and the lead unit can be remotely stopped. Note that a destruct unit has to be running to make O3. There may be a short time delay when O3 would be made without it running but it will be short (1 minute or so)

Major Alarms/Faults

1. Hi Ambient level – the equipment will continue to run but there will be an alarm
2. Hi Hi Ambient levels – the PSU/Generator are to shut down and gas flow stopped. An alarm will be issued
3. Hi Dewpoint – an alarm will be issued
4. Hi Hi Dewpoint – the PSU/Generator will shut down. Gas may continue to flow but no O3 will be made
5. Low N2 flow or Hi O2 purity – An alarm will be issued. The operator needs to put the PSU at the PSU – page AIC Control, Controller Mode in MANUAL and reduce power to a maximum of 50%. A second unit may be brought on but DO NOT EXCEED 50% POWER UNTIL N2 IS RESTORED.
6. Destruct Unit Fault/Shutdown – Alarm will be issued and the system should shut down until the other destruct comes on line
7. The PSU will protect itself and the generator with the instrumentation local to it. If there is a fault, the unit will shut down. The fault can be read at the PSU local display.
8. The Destruct will protect itself with the instrumentation local to it. If there is a fault, the unit will shut down. There are fault lights at the local display panel
9. The N2 will protect itself with the instrumentation local to it. If there is a fault, the unit will shut down. There are fault lights at the local display panel
10. Hi Off Gas – An Alarm will be issued. The plant will continue to run. It must be determined if the monitor has problems or the catalyst has a problem.
11. Hi Hi Off Gas – An Alarm will be issued and the unit will be shut down. It must be determined if the monitor has problems or the catalyst has a problem. Turn the other unit on.

SCHEDULE OF METRING PUMPS:

Equipment Number	Chemical Solution	Min Feed Range (gph)	Max Stroking Rate (spm)	Rated Discharge Pressure
6-FD-11	Liquid Alum	4.0 – 62	144	125
6-FD-12	Liquid Alum	4.0 – 62	144	125
6-FD-13	Liquid Alum	4.0 – 62	144	125
6-FD-21	Caustic Soda	4.0 – 77	144	125
6-FD-22	Caustic Soda	4.0 – 77	144	125
6-FD-23	Caustic Soda	4.0 – 77	144	125
6-FD-31	Blended Polyphosphate	0.30 – 6	120	50
6-FD-51	Non-Ionic Polymer	3.0 – 41	144	125
6-FD-71	Cationic Polymer	3.0 – 41	144	125
6-FD-72	Cationic Polymer	3.0 – 41	144	125
6-FD-73	Cationic Polymer	3.0 – 41	144	125
6-FD-81	Sodium Hypochlorite	2.0 – 38	144	125
6-FD-83	Sodium Hypochlorite	2.0 – 38	144	125
6-FD-91	Calcium Thiosulfate	0.05 – 2.5	120	125

pH measuring, continuous-reading (Rosemount)

Tag Number	Service
2-AE/AIT-011A 2-TE/AIT-011	Raw Water
2-AE/AIT-013B 2-TE/TIT-013	Actiflo Influent
3-AE/AIT-012 3-TE/TIT-011	Actiflo No. 1 Effluent
3-AE/AIT-022 3-TE/TIT-021	Actiflo No. 2 Effluent
4-AE/AIT-041A 4-TE/TIT-041	Filter Influent-pH
4-AE/AIT-041B	Filter influent - ORP
8-AE/AIT-005A 4-TE/TIT-005	Treated Water Clearwell Influent
9-AE/AIT-011A 2-TE/TIT-011	Treated Water

Low Range, continuous-reading turbidimeters (GLI Accu4)

Tag Number	Service
5-AE/AIT-112	Filter No. 1 Effluent
5-AE/AIT-122	Filter No. 2 Effluent
5-AE/AIT-132	Filter No. 3 Effluent
5-AE/AIT-142	Filter No. 4 Effluent
5-AE/AIT-152	Filter No. 5 Effluent
5-AE/AIT-162	Filter No. 6 Effluent
5-AE/AIT-004B	Combined Filter Effluent
9-AE/AIT-011B	Treated Water Pumps Discharge

SCADA Basic Alarm List (as of 4/22/04 -- still being developed)

OZONE CONCENTRATION HIGH ALARM OZONE CONCENTRATION LOW ALARM 3-ME-14 ACTIFLO TRAIN 1 SETTLING TANK SCRAPER DRIVE ALARM 3-ME-14 ACTIFLO TRAIN 1 SETTLING TANK SCRAPER DRIVE ALARM - HMI 3-ME-24 ACTIFLO TRAIN 2 SETTLING TANK SCRAPER DRIVE ALARM 3-ME-24 ACTIFLO TRAIN 2 SETTLING TANK SCRAPER DRIVE ALARM - HMI 5-P-07 BACKWASH SUPPLY PUMP #1 IN ALARM 5-MOV-03 BACK WASH SUPPLY PUMP #1 MOV IN ALARM 5-P-08 BACKWASH SUPPLY PUMP #2 IN ALARM 5-MOV-04 BACK WASH SUPPLY PUMP #2 MOV IN ALARM 3-AIT-013 CLARIFICATION BASIN #1 SETTLED WATER TURBIDITY HIGH ALARM 3-AIT-013 CLARIFICATION BASIN #1 SETTLED WATER TURBIDITY LOW ALARM 3-AIT-012 CLARIFICATION BASIN #1 SETTLED WATER #1 PH HIGH ALARM 3-AIT-012 CLARIFICATION BASIN #1 SETTLED WATER #1 PH LOW ALARM 3-AIT-023 SETTLED WATER #2 TURBIDITY HIGH ALARM 3-AIT-023 SETTLED WATER #2 TURBIDITY LOW ALARM 3-AIT-022 SETTLED WATER #2 PH HIGH ALARM 3-AIT-022 SETTLED WATER #2 PH LOW ALARM 6-P-02 C.S. / S.H.C. SUMP B LEVEL HIGH ALARM 6-P-02 C.S. / S.H.C. SUMP B LEVEL HIGH ALARM - HMI 6-P-02 C.S. / S.H.C. SUMP B LEVEL HIGH ALARM 6-P-02 C.S. / S.H.C. SUMP B LEVEL HIGH ALARM - HMI 6-FD-21 C.S. METERING PUMP #1 IN ALARM 6-FD-22 C.S. METERING PUMP #2 IN ALARM 6-FD-23 C.S. METERING PUMP #3 IN ALARM 6-LIT-121 C.S. STORAGE TANK #1 LEVEL ALARMS TIMER SETPOINT 6-MOV-21 C.S. STORAGE TANK #1 FEED MOV IN ALARM 6-LIT-122 C.S. STORAGE TANK #2 LEVEL ALARMS TIMER SETPOINT 6-MOV-22 C.S. STORAGE TANK #2 FEED MOV IN ALARM 6-FD-91 C.T.S. FEED PUMP IN ALARM 6-FD-91 C.T.S. FEED PUMP DISCHARGE PRESSURE HIGH ALARM 7-P-31 DECANT RETURN PUMP #1 IN ALARM 7-P-32 DECANT RETURN PUMP #2 IN ALARM 7-LSH-031 DECANT RETURN PUMP STATION LEVEL HIGH ALARM 7-LSL-031 DECANT RETURN PUMP STATION LEVEL LOW ALARM 4-ME-63 EXHAUST GAS BLOWER #1 IN ALARM 4-ME-64 EXHAUST GAS BLOWER #2 IN ALARM EMERGENCY STOP ALARM 5-MOV-14 FILTER #1 AIR SCOUR MOV IN ALARM 5-MOV-15 FILTER #1 BACK WASH MOV IN ALARM 5-MOV-12 FILTER #1 EFFLUENT MOV IN ALARM 5-MOV-16 FILTER #1 FILTER TO WASTE MOV IN ALARM 5-FIT-111 FILTER #1 DISCHARGE FLOW ALARM	

5-FIT-111 FILTER #1 DISCHARGE FLOW ALARM - HMI 5-MOV-11 FILTER #1 INFLUENT MOV IN ALARM 5-FIT-111 FILTER #1 DISCHARGE IN ALARM 5-LIT-111 FILTER #1 LEVEL ALARMS TIMER SETPOINT 5-AIT-112 FILTER #1 DISCHARGE TURBIDITY ALARMS TIMER SETPOINT 5-PDIT-111 FILTER #1 PRESSURE DIFFERENTIAL ALARMS TIMER SETPOINT 5-MOV-13 FILTER #1 WASHWATER MOV IN ALARM 5-MOV-24 FILTER #2 AIR SCOUR MOV IN ALARM 5-MOV-25 FILTER #2 BACK WASH MOV IN ALARM 5-MOV-22 FILTER #2 EFFLUENT MOV IN ALARM 5-MOV-26 FILTER #2 FILTER TO WASTE MOV IN ALARM 5-MOV-21 FILTER #2 INFLUENT MOV IN ALARM FILTER #2 IN ALARM 5-LIT-121 FILTER #2 LEVEL ALARMS TIMER SETPOINT 5-AIT-122 FILTER #2 DISCHARGE TURBIDITY ALARMS TIMER SETPOINT 5-PDIT-121 FILTER #2 PRESSURE DIFFERENTIAL ALARMS TIMER SETPOINT 5-MOV-23 FILTER #2 WASHWATER MOV IN ALARM 5-MOV-34 FILTER #3 AIR SCOUR MOV IN ALARM 5-MOV-35 FILTER #3 BACK WASH MOV IN ALARM 5-MOV-32 FILTER #3 EFFLUENT MOV IN ALARM 5-MOV-36 FILTER #3 FILTER TO WASTE MOV IN ALARM 5-MOV-31 FILTER #3 INFLUENT MOV IN ALARM FILTER #3 IN ALARM 5-LIT-131 FILTER #3 LEVEL ALARMS TIMER SETPOINT 5-AIT-132 FILTER #3 DISCHARGE TURBIDITY ALARMS TIMER SETPOINT 5-PDIT-131 FILTER #3 PRESSURE DIFFERENTIAL ALARMS TIMER SETPOINT 5-MOV-33 FILTER #3 WASHWATER MOV IN ALARM 5-MOV-44 FILTER #4 AIR SCOUR MOV IN ALARM 5-MOV-45 FILTER #4 BACK WASH MOV IN ALARM 5-MOV-42 FILTER #4 EFFLUENT MOV IN ALARM 5-MOV-46 FILTER #4 FILTER TO WASTE MOV IN ALARM 5-MOV-41 FILTER #4 INFLUENT MOV IN ALARM FILTER #4 IN ALARM 5-LIT-141 FILTER #4 LEVEL ALARMS TIMER SETPOINT 5-AIT-142 FILTER #4 DISCHARGE TURBIDITY ALARMS TIMER SETPOINT 5-PDIT-141 FILTER #4 PRESSURE DIFFERENTIAL ALARMS TIMER SETPOINT 5-MOV-43 FILTER #4 WASHWATER MOV IN ALARM 5-MOV-54 FILTER #5 AIR SCOUR MOV IN ALARM 5-MOV-55 FILTER #5 BACK WASH MOV IN ALARM 5-MOV-52 FILTER #5 EFFLUENT MOV IN ALARM 5-MOV-56 FILTER #5 FILTER TO WASTE MOV IN ALARM 5-MOV-51 FILTER #5 INFLUENT MOV IN ALARM FILTER #5 IN ALARM 5-LIT-151 FILTER #5 LEVEL ALARMS TIMER SETPOINT 5-AIT-152 FILTER #5 DISCHARGE TURBIDITY ALARMS TIMER SETPOINT 5-PDIT-151 FILTER #5 PRESSURE DIFFERENTIAL ALARMS TIMER SETPOINT 5-MOV-53 FILTER #5 WASHWATER MOV IN ALARM 5-MOV-64 FILTER #6 AIR SCOUR MOV IN ALARM 5-MOV-65 FILTER #6 BACK WASH MOV IN ALARM	

5-MOV-62 FILTER #6 EFFLUENT MOV IN ALARM 5-MOV-66 FILTER #6 FILTER TO WASTE MOV IN ALARM 5-MOV-61 FILTER #6 INFLUENT MOV IN ALARM FILTER #6 IN ALARM 5-LIT-161 FILTER #6 LEVEL ALARMS TIMER SETPOINT 5-AIT-162 FILTER #6 DISCHARGE TURBIDITY ALARMS TIMER SETPOINT 5-PDIT-161 FILTER #6 PRESSURE DIFFERENTIAL ALARMS TIMER SETPOINT 5-MOV-63 FILTER #6 WASHWATER MOV IN ALARM 5-MOV-02 FILTER COMMON FILTER TO WASTE MOV IN ALARM 5-LCP-01 FILTER GALLERY COMMON FLOOD ALARM 5-P-01 FILTER COMMON FILTER TO WASTE PUMP IN ALARM 5-LIT-101 FILTER INLET CHANNEL LEVEL ALARM 5-LIT-101 FILTER INLET CHANNEL LEVEL ALARM - HMI 5-ME-01 FILTER AIR SCOUR BLOWER #1 IN ALARM 4-MOV-12 LOX VAPORIZOR #1 MOV IN ALARM 4-MOV-13 LOX VAPORIZOR #2 MOV IN ALARM 6-FIT-011 L.A. / F.C. METERING PUMP #1 IN ALARM 6-FD-12 L.A. / F.C. METERING PUMP #2 IN ALARM 6-FD-13 L.A. / F.C. METERING PUMP #3 IN ALARM 6-P-01 L. A. / F. C. SUMP A LEVEL HIGH ALARM 6-P-01 L. A. / F. C. SUMP A LEVEL HIGH ALARM 6-LIT-111 L.A. / F.C. STORAGE TANK #1 LEVEL ALARMS TIMER SETPOINT 6-MOV-11 L.A. / F.C. STORAGE TANK #1 FEED MOV IN ALARM 6-LIT-112 L.A. / F.C. STORAGE TANK #2 LEVEL ALARMS TIMER SETPOINT 6-MOV-12 L.A. / F.C. STORAGE TANK #2 FEED MOV IN ALARM 4-LIT-111 LOX STORAGE TANK LEVEL IN ALARM 4-PIT-111 LOX STORAGE TANK PRESSURE IN ALARM MOCP Communication Alarm 4-FIT-123 NITROGEN SYSTEM IN ALARM 4-ME-21 OZONE GEN #1 L.C.P. 24VDC POWER SUPPLY ALARM 4-ME-21 OZONE GEN #1 EMERGENCY STOP ALARM 4-ME-21 OZONE GEN #1 ESTOP ALARM - HMI 4-AIT-021A OZONE GEN #1 IN ALARM 4-FIT-021 OZONE GEN #1 LOX INLET FLOW IN ALARM 4-MOV-21 OZONE GEN #1 LOX FEED MOV IN ALARM 4-PIT-021 OZONE GEN #1 LOX PRESSURE IN ALARM 4-TIT-021 OZONE GEN #1 OXYGEN INLET TEMPERATURE IN ALARM 4-MOV-23 OZONE GEN #1 OZONE DISCHARGE MOV IN ALARM 4-FIT-026 OZONE GEN #1 PSU UW FLOW IN ALARM 4-MOV-26 OZONE GEN #1 PSU UW MOV IN ALARM 4-PIT-025 OZONE GEN #1 PRESSURE IN ALARM 4-ME-21 OZONE GEN #1 L.C.P. REMOTE INTERLOCK LOSS ALARM 4-ME-21 OZONE GEN #1 L.C.P.-OIP REMOTE ACKNOWLEDGE ALARM 4-ME-21 OZONE GEN #1 L.C.P. UPS RUNNING LOW BATTERY ALARM 4-ME-21 OZONE GEN #1 L.C.P. UPS RUNNING ALARM 4-MOV-24 OZONE GEN #1 UW RETURN MOV IN ALARM 4-FIT-022 OZONE GEN #1 UW INLET FLOW IN ALARM 4-MOV-22 OZONE GEN #1 UW INLET MOV IN ALARM 4-PIT-022 OZONE GEN #1 UW INLET PRESSURE IN ALARM	

4-ME-22 OZONE GEN #2 L.C.P. 24VDC POWER SUPPLY ALARM 4-ME-22 OZONE GEN #2 EMERGENCY STOP ALARM 4-ME-22 OZONE GEN #2 ESTOP ALARM - HMI 4-FIT-031 OZONE GEN #2 LOX INLET FLOW IN ALARM 4-MOV-31 OZONE GEN #2 LOX FEED MOV IN ALARM 4-PIT-031 OZONE GEN #2 LOX PRESSURE IN ALARM 4-TIT-031 OZONE GEN #2 OXYGEN INLET TEMPERATURE IN ALARM 4-MOV-33 OZONE GEN #2 OZONE DISCHARGE MOV IN ALARM 4-FIT-036 OZONE GEN #2 PSU UW FLOW IN ALARM 4-MOV-36 OZONE GEN #2 PSU UW INLET MOV IN ALARM 4-PIT-036 OZONE GEN #2 PSU UW MOV IN ALARM 4-ME-22 OZONE GEN #2 L.C.P. REMOTE INTERLOCK LOSS ALARM 4-ME-22 OZONE GEN #2 L.C.P.-OIP REMOTE ACKNOWLEDGE ALARM 4-ME-22 OZONE GEN #2 L.C.P. UPS RUNNING LOW BATTERY ALARM 4-ME-22 OZONE GEN #2 L.C.P. UPS RUNNING ALARM 4-MOV-34 OZONE GEN #2 UW RETURN MOV IN ALARM 4-FIT-032 OZONE GEN #2 UW INLET FLOW IN ALARM 4-MOV-32 OZONE GEN #2 UW FEED MOV IN ALARM 4-PIT-032 OZONE GEN #2 UW INLET PRESSURE IN ALARM 4-AIT-061 OZONE CONTACT BASIN #1 DISCHARGE OZONE CONCENTRATION HIGH ALARM 4-AIT-061 OZONE CONTACT BASIN #1 DISCHARGE OZONE CONCENTRATION LOW ALARM 4-PIT-061 OZONE CONTACT BASIN #1 DISCHARGE OZONE PRESSURE ALARM 4-PIT-062 OZONE CONTACT BASIN #2 DISCHARGE PRESSURE ALARM OZONE BASIN #1 DESTRUCT UNIT IN ALARM 4-MOV-61 OZONE BASIN #1 FEED MOV TO DESTRUCT UNITS IN ALARM OZONE BASIN #2 DESTRUCT UNIT IN ALARM 4-MOV-62 OZONE BASIN #2 FEED MOV TO DESTRUCT UNITS IN ALARM 4-TSH-063 OZONE DESTRUCT UNIT #1 TEMPERATURE HIGH ALARM 4-TSL-063 OZONE DESTRUCT UNIT #1 TEMPERATURE LOW ALARM 4-TSH-064 OZONE DESTRUCT UNIT #2 TEMPERATURE HIGH ALARM 4-TSL-064 OZONE DESTRUCT UNIT #2 TEMPERATURE LOW ALARM LSHH-071 OZONE DESTRUCT GALLERY SUMP FLOOD ALARM 4-P-71 / 72 OZONE DESTRUCT GALLERY SUMP COMMON FAIL ALARM 4-MOV-25 DISCHARGE TO CONTACT BASINS MOV IN ALARM PCM-1 SECURITY INTRUSION ALARM PCM-1 SECURITY INTRUSION ALARM - HMI PCM-2 SECURITY INTRUSION ALARM - HMI PCM-3 SECURITY INTRUSION ALARM - HMI PCM3 UPS BATTERY LOW ALARM PCM-4 SECURITY INTRUSION ALARM - HMI PCM4 UPS BATTERY LOW ALARM PCM-5 SECURITY INTRUSION ALARM - HMI PCM5 UPS BATTERY LOW ALARM PCM-6 SECURITY INTRUSION ALARM - HMI PCM6 UPS BATTERY LOW ALARM 6-FD-71 P.E.C. METERING PUMP #1 IN ALARM	

6-FD-72 P.E.C. METERING PUMP #2 IN ALARM 6-FD-73 P.E.C. METERING PUMP #3 IN ALARM 6-FD-74 P.E.C. METERING PUMP #4 IN ALARM 6-FD-51 P.E.N. METERING PUMP #1 IN ALARM ALARM ACKNOWLEDGE ALL 6-FD-31 P.P.H. FEED PUMP IN ALARM 6-PSH-031 P.P.H. FEED PUMP DISCHARGE PRESSURE HIGH ALARM 6-PSH-031 P.P.H. FEED PUMP DISCHARGE PRESSURE HIGH ALARM - HMI 6-PSH-191 POTABLE WATER PRESSURE LOW ALARM REMOTE INTERLOCK ALARM 1-LIT-211 RAW WATER WETWELL LEVEL IN ALARM 1-P-11 RAW WATER PUMP NO. 1 IN ALARM 1-P-12 RAW WATER PUMP NO. 2 IN ALARM 1-P-13 RAW WATER PUMP NO. 3 IN ALARM 1-P-14 RAW WATER PUMP NO. 4 IN ALARM 6-FD-81 S.H.C. METERING PUMP #1 IN ALARM 6-FD-82 S.H.C. METERING PUMP #2 IN ALARM 6-FD-83 S.H.C. METERING PUMP #3 IN ALARM 6-LIT-181 S.H.C. STORAGE TANK #1 LEVEL ALARMS TIMER SETPOINT 6-MOV-181 S.H.C. STORAGE TANK #1 FEED MOV IN ALARM 6-LSH-002 S.H.C. STORAGE TANK #2 LEVEL HIGH ALARM 6-LIT-182 S.H.C. STORAGE TANK #2 LEVEL ALARMS TIMER SETPOINT 6-MOV-182 S.H.C. STORAGE TANK #2 FEED MOV IN ALARM 9-ME-11 AIR COMPRESSOR PRESSURE LOW ALARM 9-T-11 SURGE TANK LEVEL HIGH & LOW ALARM 9-LIT-311 SURGE TANK LEVEL ALARM - HMI 6-LSHH-003 TRUCK LOADING AREA SUMP LEVEL HIGH ALARM 9-P-11 TREATED WATER PUMP #1 IN ALARM 9-MOV-11 TREATED WATER SUPPLY PUMP #1 MOV IN ALARM 9-P-12 TREATED WATER PUMP #2 IN ALARM 9-MOV-12 TREATED WATER SUPPLY PUMP #2 MOV IN ALARM 9-P-13 TREATED WATER PUMP #3 IN ALARM 9-MOV-13 TREATED WATER SUPPLY PUMP #3 MOV IN ALARM 9-P-14 TREATED WATER PUMP #4 IN ALARM 9-MOV-14 TREATED WATER SUPPLY PUMP #4 MOV IN ALARM 7-LSH-011 TREATED WATER RESERVOIR LEVEL HIGH ALARM 7-LSL-011 TREATED WATER RESERVOIR LEVEL LOW ALARM UPS BATTERY LOW ALARM 24VDC POWER SUPPLY FAULT ALARM 7-P-11 W.W.R. EQUALIZATION TANK PUMP #1 IN ALARM 7-P-12 W.W.R. EQUALIZATION TANK PUMP #2 IN ALARM	